Fisheries Research 102 (2010) 9–15

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Discard mitigation increases skate survival in the Bristol Channel

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ARTICLE INFO

Article history:
Received 5 August 2009
Received in revised form
18 September 2009
Accepted 21 September 2009

Keywords:
Gear trials
Skate
Survival
Otter trawl
UK fisheries
Catch comparison

ABSTRACT

The survival of fish discarded after being caught can be improved by simple gear-based technical measures aimed at reducing discards. We look at the effects of three different codends on the initial health and short-term survival of trawl-caught skate (*Rajidae*), using a control codend (80 mm diamond mesh used as standard in the fishery) and two experimental codends (100 mm diamond mesh and 100 mm diamond mesh turned on the square). Both experimental nets reduced discarded numbers of fish by ~70%, with no commercial loss. This reduction in discards had an effect in reducing the total weight of the experimental codends by as much as 80%. We also placed 278 skate in onboard holding tanks for 48 h and evaluated the survival rates of fish caught in the different codends. Visual inspection of "health" at time zero was a good indicator of survival, because 86% of skate with a good health score survived ($p < 0.01$). From a further 1539 skate assessed for health, we show that fish caught in the control codend have the lowest proportional good health score (25%), followed by the 100 mm diamond mesh codend (34%) and the 100 mm square mesh codend (47%). The health of the fish caught is related to codend weight ($p = 0.01$). We conclude that technical measures aimed at reducing discards have an additional benefit; they indirectly increase discard survival, and the benefits of mitigating discards through by-catch reduction devices may be a more powerful tool in fisheries management than previously thought.

1. Introduction

A significant proportion of the global marine fish catch is discarded, a suboptimal use of fishery resources. Internationally, weighted discard rates are estimated to be 8% of global catch or 7.3 million tonnes (Kelleher, 2005). In European waters weighted discard rates are considerably higher than those estimated globally, ranging between 20 and 60% by weight (Borges et al., 2005; Catchpole et al., 2005; Enever et al., 2009a; Garthe et al., 1996). Discard rates vary considerably by gear type, but are much higher in the towed gears (Enever et al., 2007, 2009a). This study looks at mitigating discards in the Bristol Channel, a trawl fishery located in ICES subarea VII estimated by Enever et al. (2007) to discard 64% of the fish caught by number (36% by weight). The demersal trawlers operating in the Bristol Channel fishery primarily target skate (70% by landings) and form one of the UK's most notable target fisheries for skate and ray species, with annual landings (by weight) accounting for 20% for the total skate landings for England and Wales. Moreover, of the 3.8 million skate (3237 t) caught annually in this region, 2.2 million (823 t; 60% by number, 20% by weight) are subsequently discarded (Enever et al., 2009b). Skate that are discarded in this region are mostly juveniles that have little or no market value.

Unaccounted fishing mortality in batoids is recognised as a problem globally. Stevens et al. (2000) estimates that 50% of chondrichthyan (batoids and chimaeras) catches are taken as by-catch and not included in official fishery statistics or subjected to any management measures. Holden (1974) first concluded that batoids have life histories which would make them susceptible to overfishing. Characteristics include slow growth, low rates of reproduction and low fecundity, all of which counter long-term exploitation objectives. Indeed, the impact of fishing on sharks and batoids around the world is currently the focus of considerable international concern. A recent "red list" of the International Union for Conservation of Nature (IUCN) found that 26% of all chondrichthyans in waters of the Northeast Atlantic are threatened with extinction. Of these, 7% are classed as critically endangered, and 20% as near-threatened (Gibson et al., 2006). Fisheries statistics support these findings, and annual landings of skate and ray species in England and Wales have fallen from ~18,000 to 3000 t over the past 40 years (Jones et al., 2002). Additionally, Quero and Monnet (1993) studied statistics from the port of Arcachon (west France),

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0165-7836/$ – see front matter © 2009 Published by Elsevier B.V.
doi:10.1016/j.fishres.2009.09.013

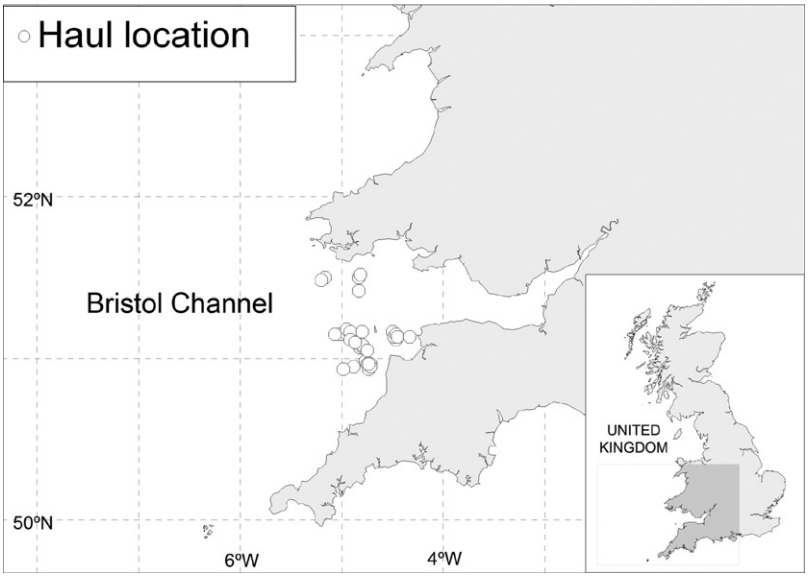

Fig. 1. The Bristol Channel and haul locations of the fish sampled.

and recorded a fall in the annual landings of skate and ray species from 1000 t in the early 1920s (23.8% of the total catch), to 3–15 t in recent years (0.3% of total catch).

As only mature fish can contribute to the next generation, survival from the juvenile phase is a key factor in the population dynamics of batoids. Batoids of all sizes (juvenile and mature) are widely caught in mixed fisheries (Enever et al., 2009a) and because of their body morphology (dorso-ventrally flattened) are not able to escape from current gear-based technical measures aimed at mitigating the catches of flatfish or roundfish juveniles (panels, increased codend mesh size), so pose scientists with a problem. Recent papers by Enever et al. (2009b) and Mandelman and Farrington (2007) both suggest that the short-term survival rates of chondrichthyans once caught and subsequently discarded were directly related to codend weight and that mitigating discards may have an effect of increasing survival of the species. The introduction of gear-based technical measures into towed fisheries in the North Sea has seen a reduction in the capture of small fish, square mesh panels (SQMPs) and larger mesh sizes in codends being associated with a significant reduction in discard rates (Enever et al., 2009a). Here we take two modified codends and assess their efficacy at reducing discards compared with that of a standard net typically used in the fishery. In addition, we measured the short-term survival of the batoids captured using specially designed onboard aquaria. Finally, we analyse the impact that the weight of these modified codends has on the survival chances of the batoids in the catch.

2. Materials and methods

2.1. The survey

The study was conducted aboard a commercial trawler with a track record of catching skate, using a twin-rigged demersal trawl in the Bristol Channel (Fig. 1). Eight trips 3–5 days long were made during June and July 2009. In all, 38 tows were conducted for a duration representative of commercial practice (5.5 ± 0.1 h) in areas where the vessel would normally fish for skate and selected by the skipper. All hauls were conducted at towing speeds of 3–5 knots in water 35–65 m deep.

2.2. Catch sampling and data analysis

Of the 38 tows, 32 were used for catch comparisons using a combination of three nets. Sixteen hauls compared a 100 mm diamond mesh codend (Experiment 1) with a 80 mm diamond mesh codend, the latter is the standard used in the fishery (the control), and 16 hauls compared the catch composition of a 100 mm diamond mesh codend turned on the square (herein referred as 100 mm square mesh codend and experiment 2) with the control. In order to eliminate bias, the control and experimental codends were switched so that they fished eight tows on both port and starboard sides of the twin-rigged net. All three codends were constructed from 4 mm single braided (green) twine (Fig. 2).

Experimental and control trawls were shot and hauled alongside each other. When brought aboard, the catches of the two nets were kept separate to allow for direct comparison. All fish (retained and discarded) were identified and measured to the nearest centimetre below. Where subsampling was necessary, retained and discarded fish numbers for each species were initially raised to haul level as a proportion of the total catch using volume-based raising factors. The difference between the control trawl and the

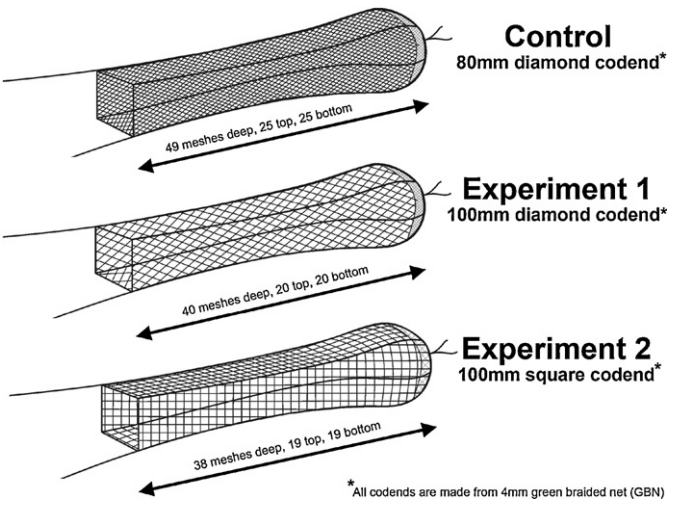

Fig. 2. A schematic of the three codends used during the study.